

VIII. NOTES ON CYPRINIDAE FROM TIBET
AND THE CHUMBI VALLEY, WITH A
DESCRIPTION OF A NEW SPECIES OF *GYMNOCYPRIS*.

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I. *Schizopygopsis stoliczkae*, Steind., and *Schizopygopsis
severzovi*, Herz.

1. Source of recent collection. Stations with their altitude.
2. Source of older collections in Indian Museum.
3. Literature.
4. Geographical range. General characters of country inhabited.
5. Is the separation of the two species *S. stoliczkae* and *S. severzovi* justified?
 - (i) Five points of distinction by means of which the two species are separated from each other by Herzenstein and Alcock.
 - (ii) The specimens of which measurements are available divided into 11 groups.
 - (iii) Analysis of the five points of distinction in 8 of the groups.
 - (iv) Variation in the relative size of the head to the body.
6. Coloration.
7. Relative frequency of this and of other species of fish in the district under consideration.
8. Breeding and migration.
9. Summary.

1. *Schizopygopsis stoliczkae*, Steind., has been obtained lately from various localities between the Chumbi valley and the town of Gyantse in the Tibetan province of Tsang. I am indebted to Captain Kennedy, I.M.S., for the greater number of the specimens, and his collection is so much the more valuable in that it was made in the course of journeys between Chumbi and Gyantse, and contains specimens from a series of localities on both the south and the north faces of the Himalaya, and also from the immediate neighbourhood of the watershed (the Tang-la). Mr. F. M. Bailey, lately British Trade Agent at Gyantse, also kindly sent me

some specimens from the Chumbi valley and I myself had found this species in considerable numbers in the neighbourhood of Gyantse in 1906-1907.

The following is a list of the localities with their altitudes :—

- (1) Ling-ma-tang, Chumbi valley, 11,500 feet. In the Ammo-chu, a tributary of the Raidak. At this point the river traverses a sedgy plain. Its breadth is roughly 10—15 yards. The fish can be seen in considerable numbers.
- (2) Phari, at the head of the Chumbi valley, eight miles S. of the watershed, 14,300 feet. In a small tributary of the Ammo-chu.
- (3) Guru, 25 miles N. of the watershed, 15,000 feet. In a hill stream which disappears into the ground.

[The streams in the latter two localities are small rivulets running off the face of barren stony mountains, but ending in broad and marshy plains. They are frozen for at least six months of the year, but nevertheless both animal and vegetable life is remarkably abundant. It should be noticed that migration of fish from the third locality is out of the question. Not only do a number of the smaller streams end by disappearing in the ground, but the only river flowing out of the Rham Tso ends in the Kala Tso, 14,600 feet above the sea, from which there is no visible outflow. The aquatic population of this area is therefore unable at any time of the year to descend lower than 14,600 feet.]

(4) Kang-ma, 30 miles S. of Gyantse, 13,900 feet. In the Nyang-chu.

(5) Gyantse, 13,100 feet. In the Nyang-chu and its tributaries.

2. I was fortunate in being able to compare this collection with two other collections of *Schizopygopsis* from Central Asia which are stored in the Indian Museum. The first is that which Dr. Stoliczka obtained during Sir Douglas Forsyth's Mission to Yarkand in 1873-74. The second consists of the specimens of *S. severzovi*, Herz., which Dr. Alcock collected while serving with the Pamir Boundary Commission of 1895.

3. The measurements of the individual fish of these two species, in the collection of the Imperial Academy of Science in St. Petersburg, are also available in the report by Dr. Herzenstein (4).

4. Stoliczka found the fish which was afterwards honoured with his name in the headwaters of the Indus in the neighbourhood of Leh in Ladakh, at an elevation of 11,500 feet above sea level, of the Oxus (Aktash, 12,880 feet, Upper Kora-Kul and Panjah) and of the Yarkand river at Sarikol.

Day (2, p. 9) doubts the accuracy of this latter record: "I am very dubious of these specimens, and hardly think that they can have been obtained from waters that flow into the Yarkand

river, as the adults have not been obtained thence. The adult however has been taken in the Oxus; and I find by the diary that on the day the specimens in question were captured, the camp was at Sarikol a few miles from a valley where a stream enters the Aksu river, a tributary of the Oxus."

The species was also found by the brothers Schlagintweit in Nari-Khorsum, presumably in the upper reaches of the Sutlej.

Herzenstein (4) describes specimens of *S. stoliczkae* from the Amu-darya (Oxus) system on the Pamirs obtained by Ssewerzoff and Grumm-Grshimailo, and a single example obtained by Grombtschewski from "Abdu-Gafar-Tom" in the Khotan river basin.

Ssewerzoff obtained the specimens which were afterwards named after him from the Pamirs (Bulun-kul and Kurasu), while Alcock's examples of this species come from "a river near Oikul, Little Pamir."

It has not hitherto been found in any river of the south face of the Himalaya with the exception of the Ammo-chu.¹

According to our present knowledge, therefore, the two forms range from Badakshan, the Pamirs and Khotan, through Baltistan, Ladakh and Nari-Khorsum, along the northern face of the Himalaya to the Chumbi valley, in a tract of country 1,400 miles long by 150—300 broad, including the upper waters of the Oxus, the Khotan river, the Indus, Sutlej and Brahmaputra and the Ammo-chu.

The character of the country in the streams of which *S. stoliczkae* is found is very uniform. Alcock writing of the Little Pamir says (1, p. 56): "The Little Pamir . . . is the broad alluvial basin of the first fifty miles, or so, of the River Aksu. Its greatest breadth is not more than four or five miles . . . at an elevation of about 13,000 feet. It is bounded north and south by grassy downs which rise to a height of 18,000 feet and culminate in sharp-cut peaks, most of these, especially on their northern faces, being capped with perpetual snow. . . . The surface of the Pamirs although largely covered with tussocks of grass and other stunted vegetation, often consists of bare stretches of hard sand and shingle coated with a saline efflorescence. . . . The river runs with some rapidity in a broad bed of boulders and often expands into marshes and lakelets, one chain of which, known as Chakmak-tin Kul or Oi Kul, is of respectable size. . . . A very characteristic feature of the Pamir in summer are the tracts of deep grassy bog that skirt the river and all its tributaries. Equally characteristic is the rolled or beaten-down appearance of the surface soil everywhere, the evident result of a long-lying weight of snow."

These sentences might have been copied almost word for word as a description of the country between Ling-ma-tang and Gyantse. There are the same snow- or spring-fed streams and

¹ Since the above was written Erich Zugmayer has also reported the finding of large numbers of *Schizopygopsis stoliczkae* in the Indus and Western Tibet. *Zool. Jahrb., Syst., Geogr. und Biol.*, vol. xxix (1910).

ivers, in places running noisily and rapidly through channels filled with boulders, again spreading out into marshes and great shallow lakes in the broad flat upland valleys.¹ At Ling-ma-tang, Phari and around the Rham Tso are the same widespreading grassy downs, although it must be admitted that to the north of the watershed the grass is not very abundant. It is a region barren of trees,—for twenty miles on the south and forty miles to the north of the Tang-la not a single tree can be seen. It is a very different country from the south slope of the Himalayas with its narrow valleys, its plunging torrents, and hillsides covered with pines.

5. The collection with which the present notice deals contains some specimens which can be referred without hesitation to Stoliczka's species, others which obviously belong to Ssewerzoff's, and again others which appear to be intermediate between the two. It was necessary, therefore, to enquire into the validity of the separation of the two species, taking into consideration the knowledge gained by the study of this new collection.

Herzenstein (4, p. 199), in defining the species *S. severzovi*, writes: "Diese Form ist auf Grund von Exemplaren beschrieben worden, welche z. Th. schon vom verstorbenen Prof. Kessler von dem typischen *Sch. stoliczkae* als *Sch. macrophthalmus* oder *Sch. stoliczkae* var. *macrophthalma* getrennt worden sind. Der Hauptunterschied besteht meiner Meinung nach in der relativen Lage der Mundspalte und des unteren Augenrandes, wie ich es in der Synopsis angeführt habe. Freilich lassen sich einige der kleineren Exemplare weniger sicher nach diesem Kennzeichen bestimmen. Doch halte ich es vorläufig für mehr passend beide Formen zu trennen, da *Sch. severzovi* ausserdem noch einige besondere prävalierende Variations-Neigungen zu zeigen scheint, so namentlich ein in Durchschnitt grösseres Auge und dunklere Färbung."

Alcock also does not accept the separation without some doubt (1, p. 14), "I was at first inclined to disagree with Herzenstein in separating this species from *S. stoliczkae*, but on comparing the large series of the latter in the Indian Museum with those collected by myself among which are numerous spawning males and females, I can find five ripe males and a ripe female all taken at the same spot, which differ constantly from ripe adults of *S. stoliczkae* in the following characters:—

- (1) they are smaller, sexually mature individuals not being longer than 175 mm.; whereas I can find no sexually mature *S. stoliczkae* less than 200 mm. long, while most are about 250 mm. and some nearly 350 mm.;
- (2) the body is higher, its height in the adult being one-sixth of its total length; whereas in typical adults of *S. stoliczkae* the body-height is only one-seventh or one-eighth of the total length;

¹ See *Rec. Ind. Mus.*, vol. ii, part iv, pl. xxvi. The upper photograph represents Chalu Bridge.

- (3) as pointed out by Herzenstein, the anterior end of the mouth cleft is on a level with the lower edge of the orbit, whereas in *S. stoliczkae* it is altogether below the level of the orbit. This is due to the fact that in *S. severzovi*:—
- (4) the eye is larger, its diameter in sexually mature adults being one-fourth, or nearly one-fourth, the length of the head; whereas in sexually mature adults of *S. stoliczkae* its diameter is only one-fifth to one-sixth the length of the head.

The six adults here separated as *S. severzovi* all came from a small ice-cold streamlet which seems to have only a periodic connexion with larger waters, so that, after all, they may be only dwarfs of *S. stoliczkae*."

For the purpose of this enquiry the various specimens have been arranged in a series of groups. It will be well first to give a summary of these groups and then to discuss the various characters given as separating the two species.

- P. 1. The specimens of *S. severzovi* from the Pamirs described by Herzenstein. (For detailed measurements of the individuals see Herzenstein, 4, p. 199.)
- P. 2. The specimens of *S. stoliczkae* from the Pamirs described by Herzenstein. (*Ibid.*, p. 195. Nos. 8734—8812.)
- P. 3. Stoliczka's collection of *S. stoliczkae* from the Pamirs and Ladakh in the Indian Museum.
- P. 4. Alcock's six specimens of *S. severzovi* from the Little Pamir (Ind. Mus. Nos. 14141—14146): *vide* pl. iii, fig. 2.
- Ch. Four specimens from the Chumbi valley (Ind. Mus. Nos. $\frac{2570}{1}$ — $\frac{2572}{1}$ and $\frac{2853}{1}$): *vide* pl. iii, fig. 1.
- D. 1. Four specimens from Guru with head characters of *S. stoliczkae* (Ind. Mus. Nos. $\frac{2850}{1}$, $\frac{2851}{1}$, $\frac{2854}{1}$ and $\frac{2855}{1}$).
- D. 2. One specimen from Guru intermediate as regards head characters (Ind. Mus. No. $\frac{2856}{1}$).
- K. 1. Five specimens from Kang-ma with head characters of *S. stoliczkae* (Ind. Mus. Nos. $\frac{2857}{1}$ — $\frac{2861}{1}$): *vide* pl. iii, fig. 3.
- K. 2. Eleven small specimens from Kang-ma (Ind. Mus. Nos. $\frac{2864-2868}{1}$, $\frac{2909-2911}{1}$, $\frac{2946-2948}{1}$).
- G. 1. Four small specimens from the Nyang-chu at Gyantse.
- G. 2. Five small specimens from marsh pools near Gyantse.

The last three groups, K. 2, G. 1 and 2, consist of fish too small for the present purpose.

We can now proceed with an analysis of the five distinguishing characters in the groups.

Analysis of differences between *S. stoliczkae* and *S. severzovi*:—

Character (a). Body higher in *S. severzovi* than in *S. stoliczkae*.

„ (b). Eye larger „ „ „ „ „

„ (c). Mouth: anterior margin on level with lower border of orbit in *S. severzovi*; below this level in *S. stoliczkae*.

„ (d). Darker colour of *S. severzovi*.

„ (e). Smaller size of sexually mature specimens of *S. severzovi*.

Character (a). The two groups named *S. severzovi* (P. 1, Ssewerzoff's, and P. 4, Alcock's) are both from the Pamirs. The relation of the body-length to the maximum body-height is 5.4 in both (see table i). That is, on the average they are higher in the body than the two groups of *S. stoliczkae* from the same region (P. 2, Ssewerzoff's, and P. 3, Stoliczka's). *Vide* table i. On consulting the table of extreme measurements, on the other hand (table iii, col. 3), it will be seen that this is only true for the average measurements: the lowest-bodied fish of the Ssewerzoff groups (6.20) is considerably lower than the highest-bodied fish of the Stoliczka groups (4.48), and indeed the latter is higher than even the highest-bodied of the Ssewerzoff groups (5.00).

Although the two Ssewerzoff groups from the Pamir (P. 1 and P. 4) have a greater average body-height than the two Stoliczka groups (P. 2 and P. 3), this average is lower than that of groups D. 1 and K. 1, which have the head of Stoliczka's type in a marked degree (character c).

Character (b). It is clear that the eye diminishes in size relatively to the head with the increase in size of the fish. Therefore groups of fish of the same average size only, can be compared in regard to this character. The two Ssewerzoff groups P. 1 and P. 4 taken together have an average length of about 150 mm. and the two Stoliczka groups from the Pamir-Ladakh region, P. 2 and P. 3, combine to very much the same average: these may be compared with the medium-sized Kang-ma K. 1 group (table i, col. 3). The three arrange themselves as follows:—Larger eye (4.3) *S. severzovi*; smaller eye (4.75) *S. stoliczkae* (Pamir-Ladakh and Kang-ma).

The characters *b* and *c* then do show some parallelism. But, again, there is considerable overlapping of the extreme measurements, some specimens in P. 3 having larger eyes (4.00) than some of P. 1 and P. 4 (4.32 and 5.00).

The evidence of the Chumbi group Ch. is, moreover, definitely against this parallelism. Their average length is only 136 mm. and therefore their eyes should be proportionately larger than in larger fish. They have the Ssewerzoff type of head (character *c*)

but their eyes are actually of the same average size (4.75) as the average of groups P. 2 and 3 (4.75), and are considerably smaller than the average of the other two Ssewerzoff groups P. 1 and 4 (4.30) (*vide* table i, cols. 4 and 5, Ch.).

Character (c) (*vide* pl. iii, figs. 1, 2 and 3). Herzenstein states that in *S. severzovi* the anterior end of the mouth-cleft is on a level with the inferior margin of the orbit, and that in *S. stoliczkae* it is below this level.

Alcock considers that this difference is due to the greater relative size of the eye in the former species. After examining the new collections from Tibet the present writer cannot agree with the view that this character is entirely dependent on the size of the eye. The heads of the two extreme types, Ssewerzoff's and Stoliczka's, differ in the following points:—

Stoliczka's (pl. iii, fig. 3)—

- (a) the lower surface of the head from the tip of the snout back to the pericardial region is almost perfectly flat;
- (b) the mouth, which opens on this flat surface some few millimetres from the tip of the snout, is entirely ventral;
- (c) since the tip of the snout lies in the lowest horizontal level, the angle formed by the frontal line curving from the snout to the occiput with the horizontal is greater than if the tip of the snout were in a higher level.

Ssewerzoff's (pl. iii, figs. 1 and 2)—

- (a) the lower surface of the head is curved, rising from the pericardium to the tip of the snout;
- (b) the mouth is thus more terminal than ventral and is only slightly overhung by the tip of the snout;
- (c) the snout being in a higher level the angle referred to is less than in Stoliczka's type.

Gradations between these two extremes occur. Stoliczka's type is more common than Ssewerzoff's.

The Ssewerzoff type of head occurs in groups P. 1 (Herz.) and Ch., and in half the specimens of P. 4; in the other half the heads incline more to Stoliczka's type as here defined.

Character (d), colour. There is no type of coloration absolutely characteristic of either the Stoliczka or Ssewerzoff head types. Spotted and uniformly coloured forms occur in both but the former is more generally uniform in colour, the latter spotted.

Character (e), smaller size of sexually ripe specimens of *S. severzovi*. In group D. 2, with the Stoliczka head type, the reproductive organs are at least as well developed as in P. 4, although the average length is 123 mm. in the former as compared with 145 mm. in the latter.

The two species, then, cannot be separated by all five characters, since different combinations occur in each group.

Table i shows the distribution of the characters distinguishing *S. stoliczkae* from *S. sewerzovi* among eight groups: col. 1 gives the group; col. 2, the average total length of the members of the group in millimetres; col. 3, average of the relation of total length to maximum body-height; col. 4, average of the relation of head-length to the diameter of the eye. In cols. 5, 6 and 7, E represents that the group belongs to the Ssewerzoff type for this character, T that it belongs to the Stoliczka type, ET that the group contains individuals of both types: col. 5 deals with the same proportion as col. 3; in Ssewerzoff's type the relation is 5.4 and less, in Stoliczka's 5.5 and more: col. 6 is the same proportion as col. 4; Ssewerzoff's type is 4.5 and below, Stoliczka's 4.6 and above: col. 7 represents the relation of the anterior end of the mouth-cleft to the lower margin of the orbit; in Ssewerzoff's type the former is on the same level or above the latter, in Stoliczka's it is below the latter.

TABLE I.

1		2	3	4	5	6	7
Group.		T. L. mm.	T. L. Mx. Bo. Ht. Charac- ter (a).	Hd. L. E. Charac- ter (b).	T. L. Mx. Bo. Ht. Charac- ter (a).	Hd. L. E. Charac- ter (b).	M. O. Charac- ter (c).
P.	1 ..	153	5.40	4.10	E	E	E
P.	2 ..	177	5.60	5.00	T	T	T
P.	3 ..	114	5.70	4.50	T	E	?
P.	4 ..	145	5.40	4.50	E	E	ET
Ch.	..	135.75	4.97	4.75	E	T	E
D.	1 ..	123	4.62	5.00	E	T	T
D.	2 ..	115	4.30	4.35	E	E	
K.	1 ..	148.8	4.51	4.70	E	T	TT

The question then arises whether the two species can be separated on the differences in the shape of the head alone (character c), and as a complete series of gradations between the two extremes occurs (pl. iii, figs. 1, 2 and 3) it does not appear to the present writer that this can be done.

If all the specimens from one particular narrow locality are brought together it will be found that one head type or the other predominates. One type may be present to the exclusion of the other but intermediates are also generally present and occasionally the opposite type as well. The specimens from Guru (D. 1 and 2) are of Stoliczka's type 4 specimens, intermediate 1; those from the Chumbi group consist of Ssewerzoff's type only; those from Kang-ma (K. 1) of Stoliczka's only. Alcock's specimens from Oikul, Little Pamir, of Ssewerzoff's 3, intermediates or Stoliczka's 3.

There is another character in which very considerable variation

exists in the species, namely in the proportion of the size of the head to the body. These differences are exhibited by the three proportions—

Length of body Length of body Length of body
Breadth of head' Length of head' Height of head'

In table ii the groups are arranged in order according to this measurement (cols. 3, 4 and 5), and it will be seen that the Pamir specimens have the smallest heads, the Kang-ma specimens the largest, while the Guru and Chumbi groups are intermediate. It is noteworthy that a classification by this character is a cross-classification to the division into the two species, since P. 1 and 4 are separated by P. 2 and 3 and P. 2 is widely separated from D. 1 and K. Table iii also shows that there is no overlapping of the extreme measurements between the Pamir and Kang-ma groups.

TABLE II.

Group.			T. L. mm.	B. L. Hd. B.	B. L. Hd. L.	B. L. Hd. Ht.	Number of species measured.
P. 1	..	..	153	9.2	4.4	6.6	5
P. 2	..	..	177	9.06	4.5	..	11
P. 3	..	..	114	8.5	4.7	6.5	12
P. 4	..	..	145	7.9	4.3	6	6
Ch.	..	..	135.75	7.42	4.15	5.90	4
D. 1	..	..	122.75	7.02	4.06	5.06	4
K. 1	..	..	148.8	6.28	4.35	5.21	5
K. 2	..	..	47	6	3.7	4.7	11
G. 1	..	..	40	6.5	3.8	5.3	4
G. 2	..	..	38	7.3	4	5.5	5
							67

The above table gives the average measurements of groups in regard to—

- col. 2, total length;
- „ 3, body length divided by head breadth;
- „ 4, „ „ „ „ „ length;
- „ 5, „ „ „ „ „ height.

Column 6 gives the number of specimens measured.

The following table (p. 82) gives the extreme measurements of individual specimens in the various groups:—

- Col. 2, total length in millimetres.
- „ 3, „ „ „ divided by maximum body height.
- „ 4, „ „ „ „ „ head breadth.
- „ 5, „ „ „ „ „ length.
- „ 6, „ „ „ „ „ height.
- „ 7, head length divided by diameter of eye.

Column 8 gives the number of specimens.

TABLE III.

Group.	Total body length. mm.	T. L. Mx. Bo. Ht.	T. L. Hd. Br.	T. L. Hd. L.	T. L. Hd. Ht.	Hd. L. E.	Number of specimens measured.
P. 1	{ 185 126 217 }	{ 5.66 5.12 6.80 }	{ 9.90 8.60 9.38 }	{ 4.66 4.21 4.83 }	{ }	{ 4.32 3.83 5.70 }	5 S. <i>severzovi</i> , Herzenstein. Pamirs.
P. 2	{ 125.5 185 60 }	{ 4.48 6.60 5.00 }	{ 8.74 9.50 8.00 }	{ 4.83 5.00 4.25 }	{ .. 7.30 5.50 }	{ 4.14 5.25 4.00 }	11 S. <i>stoliczkae</i> , Herzenstein. Pamirs.
P. 3	{ 154 136 150 }	{ 6.20 5.00 5.20 }	{ 8.50 7.20 8.30 }	{ 4.50 4.22 4.30 }	{ 6.30 5.50 6.25 }	{ 5.00 4.00 5.00 }	12 S. <i>stoliczkae</i> , Forsyth M. Pamirs and Leh.
P. 4	{ 136 128 135 }	{ 5.00 4.70 5.00 }	{ 8.30 7.00 7.35 }	{ 4.30 4.00 4.25 }	{ 5.50 6.25 5.75 }	{ 4.00 5.00 4.50 }	6 S. <i>severzovi</i> , Alcock. Little Pamir.
Ch.	{ 113 116 133 }	{ 4.35 4.75 4.25 }	{ 6.75 6.50 6.00 }	{ 3.75 4.50 4.20 }	{ 5.00 5.50 5.00 }	{ 5.00 5.00 4.50 }	4 Chumbi. Bailey, Kennedy.
D. 1	{ 60 34 45 }	{ 4.50 4.00 5.00 }	{ 6.50 5.50 6.70 }	{ 4.00 3.50 4.00 }	{ 5.00 4.50 5.50 }	{ 4.00 3.00 3.50 }	5 Kang-na, medium. Kangna, small.
K. 1	{ 33 45 33 }	{ 4.50 }	{ 6.25 7.23 7.00 }	{ 3.70 4.00 4.00 }	{ 5.00 6.00 5.30 }	{ 3.20 }	11 Gyantse, river. Gyantse, marsh pools.
K. 2	{ 33 45 33 }	{ 4.50 }	{ 6.25 7.23 7.00 }	{ 3.70 4.00 4.00 }	{ 5.00 6.00 5.30 }	{ 3.20 }	4 Gyantse, river.
G. 1	{ 33 45 33 }	{ 4.50 }	{ 6.25 7.23 7.00 }	{ 3.70 4.00 4.00 }	{ 5.00 6.00 5.30 }	{ 3.20 }	5 Gyantse, marsh pools.
G. 2	{ 33 45 33 }	{ 4.50 }	{ 6.25 7.23 7.00 }	{ 3.70 4.00 4.00 }	{ 5.00 6.00 5.30 }	{ 3.20 }	5 Gyantse, marsh pools.

The differences between the specimens from the Pamir and those from the Nyang-chu at Kang-ma may be due to differences in the character of the waters they inhabit or to differences in nutrition. The Nyang-chu is a stream of a most muddy character and it is possible that muddiness of the water, by interfering with respiration, tends to cause an increase of the gill-surface and hence an increase in size of the gill-containing portion of the head.

It should be noted that the relative breadth of the head is less in group G. 2 than in group G. 1 although these two groups are composed of young fish of practically the same size. G. 1 were obtained in the muddy streams around Gyantse, G. 2 from marsh pools close to Gyantse the water of which was entirely free from mud. The value of this observation is of course considerably diminished by the small numbers of the fish in the two groups and their small size.

The specimens from the Nyang-chu were also exceptionally fat and well nourished, whereas those from the Pamirs were of a more hungry appearance.

6. There are considerable variations in the colour of different individuals. The Chumbi race is roughly separated in this respect from the Nyang-chu race.

The following is a note of the colour of a fresh fully grown fish from the Nyang-chu: "Head and body above the latera line a mixture of olive-green and slate-blue, this colour extending somewhat below the lateral line posteriorly. A faint purplish stripe about 3 mm. broad along each side of the dorsal line, commencing at the dorsal fin and extending backward. Flanks below the lateral line rather dull orange-gold; belly dull white."

In the Chumbi valley, on the other hand, the back is pale olive in the anterior half, pale steel-blue in the posterior, and the black pigment is concentrated into irregular spots which are not by any means closely set. The ground colour of the head in spirit is greyish white. The flanks have the golden tinge, but the belly is silvery. Altogether the Chumbi fish is more elegant than its heavily-built cousin from the north. Steindachner (7) describes the colour of the Leh specimens as follows: "Die obere Körper hälfte ist grau, die untere silberfarben. Kopf, Rumpf und Flossen sind mit kleinen schwarzbraunen Flecken und Pünktchen geschprenkelt,"—apparently they resemble the Chumbi specimens.

Specimens from Phari, Guru and Dochen are intermediate between those of Chumbi and the Nyang-chu in respect of colour as well as of general shape. They have the spots of the former but less clearly defined, and the olive ground colour of the back is lighter than in the Nyang-chu and darker than in the Chumbi race.

As I have stated above, the Ssewerzoff type is more often spotted than the Stoliczka: thus Ch. and P. 4 are mainly spotted whereas K. 1 are entirely plain. On the other hand several in D. 1 are spotted.

In the fry (70 mm. and under) the back is of a chocolate-brown with a slight tinge of slate, and there are two rows of irregular

spots on either side, one close to the dorsal line the other on the lateral line.

7. In the district between Chumbi and Gyantse *S. stoliczkae* is the predominant fish. The only species which at all approaches it in numbers is the small loach which also bears the name of *Stoliczka* (*Nemachilus stoliczkae*, Day). Our present subject is, however, much more numerous than even this common species. During the summer numbers were caught every day in the river at Gyantse, while the irrigation channels, the small shallow ponds amongst the fields, and the pools of the marshes at Sechen were alive with shoals of the fry.

In comparison with the above two very numerous forms other species are somewhat uncommon. During an entire summer, although I had about half a dozen men in my employment who all had some acquaintance with the art of fishing, I did not obtain more than four or five specimens of any other species. Arranged roughly in order of frequency the other species found would run (*vide* Lloyd, 5): *Ptychobarbus conirostris*, Steind., *Oreinus baileyi*, Lloyd, *Schizothorax macropogon*, Regan, and *S. o'connori*, Lloyd, *Gymnocypris* (*Schizopygopsis*) *stewartii*,¹ Lloyd, and *Paraxosoma stoliczkae*, Day.

It is clear that this fish is also one of the most common if not the most common of the inhabitants of the upper waters of the Indus, Oxus and Sutlej.

8. Breeding and migration.—The breeding season in the neighbourhood of Gyantse appears to occur about June. In the less favoured waters near the watershed it is probably somewhat later. Adults with large ovaries and testes are found in the former district as early as March when the river is still partially covered with ice and the smaller streams and channels are completely frozen over.

Small post-larval fish (*vide* pl. iii, fig. 4) measuring 14-15 mm. in length were caught among the water-weeds of a shallow pond near Gyantse on the 9th July. I believe that these are the young of *S. stoliczkae*; they are elongated narrow little beings, the maximum height including the fins being to the length as 1 : 7. The head is roughly cylindrical, the snout is rounded and projects beyond the mouth. There is an upper and a lower lip at the corners of the mouth; and the mouth and lower jaw closely resemble those of the reputed parent.

The following are the measurements of two specimens:—

Total length	14 mm.	15 mm.
Length of head	2·8 „	2·5 „
Snout to commencement of preanal fin	4·5 „	4 „
„ „ „ „ dorsal „	6·8 „	6·5 „
„ „ anus	9·5 „	10 „

¹ This animal was described by Lloyd as *Schizopygopsis stewartii*, but as the mouth is terminal and the lower jaw does not bear a sharp horny cutting edge, it appears more in place in the genus *Gymnocypris*.

Anus to tail ..	..	..	4.5 mm.	5 mm.
Pectoral fin, length ..	..	..	..	1.5 ,,
Maximum height ..	..	..	2	,, ..

The caudal fin is in process of being formed on the upturned end of the cord. The pectoral fins arise close behind the gill-opening; ventral not present. The dorsal and anal fins are continuous round the tail. There is a preanal fin.

They are marked with pigment of two kinds—chocolate-brown and black. The former appears to be situated very superficially in the skin; the latter lies more deeply in mesodermal structures such as the peritoneum and periosteum. The skin is so delicate as to be transparent.

The brown pigment occurs in round corpuscles on the back of the head and body, and in stellate corpuscles on the flanks, on the caudal fin and on either side of the ventral-median fins. The black pigment, on the other hand, is found along the lateral line, on the abdomen and in a few corpuscles on the head.

In view of what is known regarding the development of other carp, such as *Cyprinus carpio*, *Leuciscus rutilus* and *idus*, and *Alburnus lucidus* (Ehrenbaum, 3), we will be safe in regarding these young forms as being from 10—20 days old, so that, allowing 4—5 days for hatching, the eggs must have been laid in the second half of June.

Coming to the older fry, the following table gives the measurements in millimetres of the specimens taken during different months of the year:—

March	..	30, 32, 42, 43, 45, 47.—Gyantse, in the Nyang-chu, under ice.
April	..	{ 22, 26, 27, 31, 34, 37, 42, 49.—Gyantse, in marsh pools. 125.—Ling-ma-tang.
July	..	{ 14, 15, 27, 31, 34, 45, 53, 60, 135.—Gyantse. 58, 103, 120.—Dochen. 135.—Ling-ma-tang.
August	..	70.—Phari.
November	..	32, 35, 36, 40, 42.—Gyantse.

The November group, clearly, are in their first year, the March and April groups from Gyantse in their second; there is, however, practically no difference in the measurements if we leave out of account the 125 mm. specimen from Ling-ma-tang. It is therefore probable that an average of 40 mm. represents the first summer's growth, that growth does not occur in the winter months or until May or June and that the 125 mm. specimen was in its third year. The reproductive organs of specimens of about this size are still immature.

Arranging the specimens in the order of their age we would probably get the following result:—

First year.

June	..	..	Spawning.
July 9th	..	..	14—15 mm.
„ 27th	..	..	26 „
„ „	..	..	34 „
November	..	..	32—42 „

Second year.

March	..	..	31—57 mm.
April	..	..	22—49 „
July	..	..	45—60 „
August	..	..	70 „

Third year.

April	..	..	125 mm.
July	..	..	103—135 „

All the inhabitants of Gyantse whom I consulted in regard to obtaining fish during the winter agreed that the larger fish migrated from the Nyang-chu to the Bralmaputra (Tsang-po) for the winter and returned to breed in spring. It is certain that I did not obtain any large fish during this season, but this fact could also be accounted for by the hibernation of either the fish or the fishermen. We shall see that in the neighbourhood of Dochen fish of the genus *Gymnocypris* attain to a great size and complete sexual maturity although unable to migrate below 14,600 feet.

Enemies.—The only predatory fish in the district under consideration is *Gymnocypris stewartii*, Lloyd. This animal undoubtedly preys on the fry of its ally *Schizopygopsis stoliczkae*, but it does not appear to be very numerous. I have heard from anglers who have had considerable experience in Kashmir that “snow trout” occur above the Mahseer. *Schizopygopsis stoliczkae* is certainly included in the vague group of snow trout, and it is highly probable that its descent to lower levels is prevented by the voracious *Barbus tor*. The geese and duck which occur in great numbers on the Rham Tso and along the Nyang-chu must be reckoned among its most active enemies.

9. Summary.—It is not justifiable to separate *Schizopygopsis severzovi* from *S. stoliczkae* as a distinct species, since they can only be distinguished by one character and a complete series of gradations occur from the one extreme type of head to the other. The fish from any single narrow locality appear to incline to one type or the other. Thus all specimens from Kang-ma are Stoliczka's type, from Guru Stoliczka's, the Chumbi valley Ssewerzoff's. The Oikul group P. 4, on the other hand, contains both the extremes as well as intermediates.

The western members of the species differ from the eastern Tibetan in the size of the head relatively to the body, the head

in the former being narrower, shorter and lower than in the latter. The Chumbi valley race is intermediate in this proportion. Variation in this character is independent of variation in head form.

The species inhabits an extensive but clearly defined area extending from Badakshan and the Pamirs to the Eastern Himalaya and including the upper waters of the Oxus, Indus, Sutlej, and Brahmaputra (Tsang-po). On the south face of the Himalaya it has hitherto been found in the Chumbi valley only.

Its characteristic habitat is in the streams and small rivers of the open, treeless, flat, grassy uplands at an elevation of 11—16,000 feet: broad valleys in the centre of which a river runs with moderate rapidity, while on either side are marshy pools fed by springs, shallow ponds or irrigated land.

It is a highly successful and very numerous species, closely adapted to its surroundings. It breeds in June and possibly also in May and July. Sexual maturity is not attained before the fourth year.

Table iv (p. 88) gives measurements of the individual fish in groups P. 4, D. 1, D. 2, K. 1 and Ch., in regard to the following characters. Column 2 gives the registered number of the specimen in the Indian Museum:—

Col. 3,	length of body in millimetres.
„ 4,	$\frac{\text{total length}}{\text{maximum height of body.}}$
„ 5,	$\frac{\text{total length}}{\text{maximum breadth of head.}}$
„ 6,	$\frac{\text{total length}}{\text{length of head}}$
„ 7,	$\frac{\text{total length}}{\text{height of head.}}$
„ 8,	$\frac{\text{length of head}}{\text{diameter of eye.}}$
„ 9,	relation of anterior margin of mouth-cleft to the lower margin of orbit.

II. THE ADULT AND YOUNG FORMS OF *Gymnocypris waddellii*, REGAN.

Gymnocypris waddellii, Regan (6).

Ind. Mus. Nos. F. $\frac{2862}{1}$, $\frac{2863}{1}$ and $\frac{2844-2849}{1}$.

Two adults and six young were taken by Capt. Kennedy in a stream flowing into the Rham Tso near Chalu Bridge (*vide* pl. iii, fig. 5).

The following description is taken from the two adults:—

Length 417, 440 mm. D. ii. 7, 8. An. ii. 6. P. i. 21. V. i. 9.

TABLE IV.

Group.	Regd. No. of specimen.	Body length. mm.	B. L. Mx. Bo. Ht.	B. L. Mx. Hd. Br.	B. L. Hd. L.	B. L. Hd. Ht.	Hd. L. E.	Ant. margin Mouth. Lower edge of Eye.
P. 4	{	154	5.3	7.2	4.22	5.5	5	2 mm. below.
		149	5.2	8	4.5	6.1	4.5	3 mm. below.
		150	5	7.8	4.3	5.8	4.8	"
		140	5.2	8	4.3	6.1	4.1	1 mm. below.
		144	5.6	8.3	4.3	6.3	4	At level.
		136	6.2	8.5	4.3	6.3	4.5	"
Average of group P. 4	..	145.5	5.4	7.9	4.3	6	4.5	
D. 1	{	128	4.35	7.35	4.25	5.00	5.00	3 mm. below.
		113	5.00	7.00	4.00	5.25	5.00	"
		115	4.35	6.75	3.75	5.00	5.00	6 mm. below.
		135	4.75	7.00	4.00	5.00	5.00	"
		122.75	4.61	7.02	4.00	5.06	5.00	
		..						
Average of typical Stol. Dochon group.	..							
D. 2	{	115	4.30	7.50	4.20	4.75	4.35	2 mm. below.
		166	4.75	6.20	4.50	5.35	4.75	
		133	4.25	6.35	4.35	5.50	4.50	
		150	4.50	6.35	4.20	5.00	5.00	
		155	4.35	6.00	4.35	5.20	4.75	
		140	4.70	6.50	4.35	5.20	4.50	
Average of group K. 1	..	148.8	4.51	6.28	4.35	5.21	4.70	
Ch.	{	150	5.00	8.35	4.35	6.25	4.50	
		130	4.70	7.35	4.00	6.00	4.50	
		128	..	7.00	4.25	6.00	5.00	
		135	5.20	7.00	4.00	5.35	5.00	
		135.75	4.96	7.42	4.15	5.90	4.75	
		..						
Average of group Ch.	..							

I was not able to find the small first dorsal spine described by Tate Regan in these specimens.

The snout is blunt, the mouth terminal, jaws equal. The greatest height of the body is attained very shortly behind the head. The distance from the anterior end of the dorsal fin to the snout is less than to the rudimentary rays of the caudal.

Colour.—One specimen is of a dull slate colour on the back of head and body, with a dull white belly and a tinge of gold along the lateral line posteriorly; in the other the pigment of the back is aggregated into small spots about 1 mm. in diameter which are set closely with very narrow spaces between.

The detailed measurements are given in table v (p. 91).

Following Herzenstein's key (4)—

The second dorsal spine is well developed and has somewhat flat teeth; the anterior end of the mouth is below the level of the lower margin of the orbit; there are no scales on the belly in front of the ventrals; the gill-rakers on the first branchial bar number, outer row 17, inner 30. The distance from the beginning of the dorsal to the snout is less than to the rudimentary rays of the caudal. This species therefore comes near *Gymnocypris roborowskii*, Herz. It differs from the latter in the proportion of the maximum height of the body to the length: $6\frac{2}{7}$ — $5\frac{2}{5}$ in *roborowskii*, $4\frac{1}{2}$ in *waddellii*.

The specimens with which we are dealing at present differ from the description of *G. waddellii* given by Tate Regan in that the anterior edge of the upper jaw is distinctly below the lower margin of the orbit. In the specimen of the species (one of the types) which was kindly presented by the British Museum to the Indian Museum, I find, however, that it is somewhat doubtful whether the anterior edge of the upper jaw is not also below the lower margin of the orbit, and, taking into account the differences of size and of the methods of preservation of Waddell's and Kennedy's specimens, it does not appear justifiable to separate them by so small and doubtful a distinction.

Both specimens were females; one was ripe, the other was not so owing to extreme infection with hydatids. In the ripe specimen the largest ovarian ova attain the impressive size of 2.5 mm. in diameter, almost double that of the extruded eggs of *Cyprinus carpio* and *Gobio fluviatilis* (Ehrenbaum, 3, pp. 132 and 135). The snout bears a pad of sharp-pointed horny nuptial tubercles, giving a sensation like a nutmeg-grater to the finger. Rows of large glands are developed on the anal fin, which even between the rays is of almost cartilaginous consistency. The scales of the anal sheath are very prominent, are attached by their bases only and measure as much as 10×9 mm. The glands and the sheath are used presumably in attaching the eggs to the substratum.

It was mentioned above in dealing with *Schizopygopsis stoliczkac* that the waters of the Rham Tso and Kala Tso are isolated by the subterranean egress of the Nyang-chu from the latter

lake; these large fish are therefore never able to migrate below 14,600 feet.

Gymnocypris waddellii, Regan: young forms.

Six specimens from a stream running into the Rham T'so near Chalu Bridge, obtained by Capt. Kennedy, I.M.S., on 30th July, 1909. They are from the same stream as the two large specimens.

Br. iii. D. ii. 8. An. ii. 6. P. i. 19. V. i. 9.

General shape.—This is an elegant fish which does not offer the ground-feeding appearance of its low-born parents and of many of its relatives. This is due chiefly to the fact that there is no humping of the back in front of the dorsal fin. The mouth is practically terminal, being only very slightly overhung by the upper lip and is above the level of the lower margin of the orbit. The maximum height of the body is situated at the commencement of the dorsal fin. The length of body in front of the commencement of the dorsal fin is to that behind this point as 1 is to 1.14. The postdorsal height is to the maximum height as 1 is to 1.35. The height of the tail is to the maximum height as 1 is to 2.87. The length of the first spine of the dorsal fin is to that of the second as 1 is to $1\frac{1}{3}$; the second is serrated in its lower two-thirds, pointed above.

Gill-rakers of first bar number, inner row 19—20, outer row 12.

Colour.—Black or blackish grey with moderate-sized darker brownish spots most marked along lateral line; belly silvery. Dorsal and caudal fins blackish grey; pectorals, ventrals and anals not pigmented.

The largest specimen contains fairly well-developed testes.

III. *Gymnocypris hobsonii*, sp. nov.

(Plate iii, fig. 6.)

A single specimen in the Indian Museum (No. $\frac{152}{1}$) presented by Mr. H. E. Hobson of the Imperial Chinese Customs Service. According to the entry in the register it was obtained from the eastern confines of Tibet.

It measures 145 mm. in length including the caudal fin, 120 without the caudal.

Br. iii. D. ii. 8. A. ii. 5. P. i. 15. V. i. 18.

The mouth is subterminal; the lower jaw slightly shorter than the upper. The anterior end of the mouth is slightly above the level of the lower margin of the orbit. The maximum height of the body is attained about the level of the anterior end of the dorsal fin. The distance from the anterior end of the dorsal to the snout is considerably less than from the same point to the base of the caudal (1 : 1.23). The second dorsal spine is strongly toothed in its lower half.

The animal is of delicate build; the fin-rays fine.

Colour in spirit.—Silvery with yellowish brown underlying colour on back of head and body.

Following Herzenstein's key (4)—

The dorsal spine: the upper half is segmented, the lower half bears well-developed teeth. The anterior end of the mouth-cleft lies slightly above the lower margin of the orbit. The gill-rakers on the first pharyngeal bar number, outer row 11, inner row 15. Among the species described by Herzenstein it appears to approach most closely to *G. maculatus*, Herz. It is separated from the latter by the differences in the fin formulae, by the absence of "humping" in front of the dorsal fin, by the smaller numbers of the pharyngeal teeth, by the forward position of the dorsal fin and by the colour. No grey coloration of back; no spots.

It differs from the young of *G. waddellii* in the following points: An. ii. 5 (not ii. 6); V. i. 18 (not i. 9). Does not slope so rapidly from the commencement of the dorsal fin, thus the maximum body height is to the post-dorsal as 1.10 to 1 (not 1.35 to 1). Maximum body height to the minimum is as 2.30 to 1 (not 2.87 to 1). The predorsal body height is to the postdorsal as 1 to 1.23 (not 1 to 1.14). The length of the first dorsal spine to that of the second is as 1 to 2 (not as 1: 1 $\frac{1}{3}$). The numbers of the pharyngeal teeth, the forward position of the dorsal fin, and the difference of colour.

The following table gives the measurements of two adult specimens of *Gymnocypris waddellii*, Nos. $\frac{2862}{1}$ and $\frac{2863}{1}$, of one young specimen of this species, No. $\frac{2849}{1}$, and of *G. hobsonii*, sp. nov., No. $\frac{452}{1}$:—

TABLE V.

Indian Museum Register No.	..	..	$\frac{2862}{1}$	$\frac{2863}{1}$	$\frac{2849}{1}$	$\frac{452}{1}$
Total length in millimetres	..	..	417	440	125	145
Body length	..	..	360	380	101	122
Body length: maximum body height	..	..	4.50	5.00	5.40	5.50
Maximum body height: postdorsal	..	..	1.46	..	1.35	1.10
Maximum body height: minimum	..	..	3.10	..	2.87	2.30
Body length: length of tail from posterior of base of anal.	..	..	6.00	..	5.50	5.00
Length of tail: height of tail	..	..	2.50	..	2.30	2.90
Body length: head length	..	..	4.35	4.25	4.20	4.60
Head length: head breadth	..	..	1.50	..	1.80	1.90
Head length: head height	..	..	1.50	..	5.80	1.45
Breadth of mouth: length of mouth	..	..	1.65	..	1.20	1.50
Head length: diameter of eye	..	..	6.20	6.00	4.20	4.50
Interorbital: diameter of eye	..	..	2.30	..	1.10	1.60
Head length: postorbital head length	..	..	1.65	..	2.00	1.85
Body length: base of dorsal	..	..	8.00	..	6.60	7.30
Height of dorsal: base of dorsal	..	..	1.20	..	1.20	1.30
Maximum height of dorsal: minimum	..	..	2.30	..	2.00	2.00
Body length: pectoral fin length	..	..	6.30	..	5.20	5.50
Body length: ventral fin length	..	..	7.50	..	6.30	6.40
Body length: head breadth	..	..	6.50	7.00	7.50	9.00
Body length: head height at level of posterior edge of opercle.	4.75	5.50	5.35	6.50

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